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HISTORY OF THE MK 5 WARHEAD (U)

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TIMETABLE OF MK 5 WARHEAD EVENTS

1900	Rocketry has beginnings as a science.
1929	Nazis start intensive study of guided missiles.
Early 1946	Rand Project founded. Early rocket-study work.
3-46	Army Air Forces institute work on Project MASTIFF, an experimental missile.
1-10-47	Early proposals for atomic warheads.
4-29-49	Division of Military Application requests views of Military Liaison Committee on missile/atomic warhead work.
1-27-50	Detailed studies of missile/atomic warheads approved.
6-21-50	Sandia Weapons Development Board accepts cognizance of missile/warhead work.
10-1-50	Department 1270 established at Sandia for missile/warhead design.
9-11-51	Military characteristics for XW-5 Warhead issued.
8-53	Mk 5 Mod 0 Warhead design released.
7-54	Mk 5 Mod 0 Warhead enters production.

Mk 5/REGULUS

1-50	Project approved by Secretary of Defense.
1-51	Missile/warhead placed in active design.
9-10-51	XW-5/REGULUS Ad Hoc Working Group meets.
8-18-52	RAM Project initiated.
10-28-52	Flight tests of XW-5/REGULUS started.
9-53	Design release of Mk 5/REGULUS.
4-54	Initial production of Mk 5/REGULUS.

5-27-52	HERMES reinstated; to be mated to Mk 5 Warhead.
10-16-52	Budget cuts delay program.
9-18-53	Program terminated.

Mk 5/F-101

4-9-53	Program established by Joint Chiefs of Staff.
8-53	XW-5/F-101 Joint Project Group formed.
3-56	Program canceled.

The success of the Germans in developing the V-missiles and the later appearance of the atomic bomb led observers to believe that a quick "marriage" of the two would follow and inaugurate an era of "pushbutton warfare." Such estimates failed to evaluate properly the complexities attendant on the development of each device and the relatively primitive state of each.[2] Lacking were such factors as reliable guidance systems, competent propulsion systems, shock-resistant warheads, and the high-quality, or "clean-room," type of manufacturing facilities yet to be developed. However, early military characteristics for an air-to-ground missile had been proposed by the Army Air Force October 19, 1945, envisioning a warhead 60 inches in diameter, 130 inches long, and 11,000 pounds in weight (in obvious reference to the Fat Man bomb), although missiles capable of carrying a warhead of this size and weight would not be available for several years.

In March 1946 the Army Air Force directed the Air Materiel Command to develop an experimental missile, and this project was given a code name of MASTIFF.[3] At the time, little information regarding MASTIFF was made available to those working on the atomic bomb, but in one of his last actions, December 12, 1946, as head of the Manhattan Engineer District and prior to AEC assumption of control, Brig. Gen. Leslie R. Groves informed the Los Alamos Scientific Laboratory concerning the project, and stated that it envisaged installation of an atomic warhead in an air-to-ground guided missile.

This information was referred to the Z Division on January 10, 1947, with a request that preliminary analysis be made, but that any sizable amount of development work be deferred until later in the year when the work load was expected to taper off.[4] Subsequently, little was done on the project in either AEC or military circles beyond a general study that contemplated use of a plane-launched drone which would glide 300 miles to a target at a speed of 300 miles per hour. However, a drone with this speed was felt to be highly vulnerable to antiaircraft fire, and the existing scarcity of nuclear material, together with the inaccuracy of drone control systems, caused apprehension that an atomic weapon might be used to bomb some unoccupied field. In mid-1947, missile development for the MASTIFF project

Subsequently, separate conferences were held with the three Services and Sandia Base representatives of the Armed Forces Special Weapons Project. These conferences explored the details of weapon-missile relationships, placing emphasis on Mk 5 and Mk 8 Warheads.

The Sandia Weapons Development Board provided a common forum for designer and user of atomic weapons and, in a meeting June 21, 1950, agreed to accept responsibility for coordinating guided-missile and atomic-warhead development. The Board proposed that a strong missile subcommittee be formed, but temporarily deferred appointments to this subcommittee, pending arrival of new officer assignments at Sandia and Kirtland Air Force Bases.[8]

The Division of Military Application had noted, in a letter dated June 14, 1950, that some controversy had arisen over the subject of responsibility for warhead fuzing. Army Ordnance had assumed that the Atomic Energy Commission would handle fuze development, but the AEC felt that the fuze characteristics would be strongly affected by missile operation and environment, and therefore the fuze should be designed by the missile agency.[9]

This subject was discussed in the June 21, 1950, meeting of the Sandia Weapons Development Board. One proposal was that the AEC provide funds for fuze development and retain nominal control of the project, with the work being accomplished by Army Ordnance or missile contractor. The Board in general felt that the missile was simply a carrier, that it replaced the aircraft carrying bombs, and that the fuze was part of warhead development. However, it was recognized that there was no easily defined line of demarcation between warhead and missile (such as between bomb and bomber), and the eventual ruling was that a decision on fuzing design responsibility would be made for each individual missile-warhead project. The Board proposed that AEC budget for fuzing development costs in the immediate future and that these funds be allocated to the military or AEC contractor assigned responsibility for fuze development.

involved, that of ballistic (where the missile was launched upward and then fell into a target) and that of release from a carrier downward onto a target.

The Division of Military Application notified the Military Liaison Committee, January 19, 1951, that increasing requirements for various combinations of missiles and warheads had reached the point where standardization of warhead design was becoming difficult, if not impossible, to achieve. It was felt that the design of the Mk 5 and Mk 7 Warheads had progressed to the point where these warheads could be proposed for marriage with missiles and eliminate any need for alternate warheads.[16]

A nomenclature system having the prefix "XW" to identify warheads under design, similar to the "TX" identification for bombs, was authorized in mid-January 1951. This prefix was followed by the warhead identification (Mark number) and was coupled with the missile designator for complete missile-warhead nomenclature. The "X" stood for experimental, and the "W" for warhead. A typical example was: XW-5/REGULUS.[17]

Detailed design was meanwhile proceeding on the arming system. It was felt that automatic arming should be provided, which would take place only after the missile had crossed into enemy territory, and it had been proposed that the missile guidance system be used to signal this fact. However, there was such a complexity of missiles, with different guidance systems, that this was found to be impracticable. It was possible, however, to provide a system that would sense the initial missile speed, the existence of high-enough thrust for long-enough time, the attainment of sufficient altitude, and the pursuance of the correct direction. All these factors could be gaged by gyroscopes, clocks and acceleration switches, and a system could be devised to permit nuclear insertion only when all these factors had been met or exceeded. Sandia provided such a system for all missile-warhead combinations, with the gyroscope, clock, or switch shorted out when a given missile had no need to measure that particular factor.[18]

Sandia presented a status report on its warhead-missile program February 23, 1951, when it was visited by Kaufman T. Keller, Chairman of the Board of the Chrysler Corporation, who had been appointed Director of the Guided Missiles Office by the Secretary of Defense. Keller noted that he had visited a good many places in his work as Missile Czar, but that he was "not going to worry about a place as obviously competent as this one." High praise indeed for Sandia work in this new field.[19]

Work began in earnest on warhead designs after AEC budgetary decisions were made May 31, 1951. It had become evident that much redesign would be required to strengthen the Mk 4 before it could be used as a warhead, and it was also evident that missiles capable of carrying such a heavy warhead were still some years in the future. Thus it was decided to suspend consideration of either the Mk 4 or Mk 6 weapon for current missile applications.

The question of fuzing responsibility was again raised. The first Ad Hoc Working Group to take action in this area, that for the XW-7/CORPORAL, recommended that Sandia provide an interim fuzing system, with Army Ordnance being responsible for the ultimate fuzing design. This proposal was approved by the Sandia Weapons Development Board June 27, 1951, and similar suggestions for the XW-5/REGULUS and XW-5/MATADOR were made and accepted in September and December 1951. These decisions were based on the fact that Sandia fuzes developed for bomb programs were the only systems capable of meeting time scales and adequately accomplishing the technical job.

Allocation of ultimate fuze design to the Army resulted in a request from that agency for AEC funds to develop an ultimate fuze for the XW-7/CORPORAL.[20] This request was referred to the Board, which decided in January 1952 to reduce the scope of the CORPORAL ultimate fuzing study to that of feasibility investigation.[21]

TRITON missiles. The warhead was not to exceed 44 inches in diameter, 77-1/2 inches in length, and 3000 pounds in weight. (b)(1), (b)(3)

Nonradiating fuzes were felt to be highly desirable, setting of burst height was to be possible just prior to missile launching, and preflight checks were to be of a simple accept or reject type.

The warhead was to be capable of withstanding accelerations of +7 g's and -5.5 g's along the longitudinal axis of the missile, although the RIGEL might require resistance against +20 g's. Accelerations of ±3.5 g's along the lateral axis and ±4 g's along any other axis would also have to be withstood. The warhead was to be able to resist temperatures from -65 to +160°F, and altitudes up to 80,000 feet. Air-launched missile warheads would have to withstand flights in the parent aircraft of up to 15 hours at 40,000 feet; and submarine-launched missiles would have to provide for storage of the warhead in the missile for as long as 75 days.[24]

A variety of interpretations had previously been given to definition of warhead and warhead installation, and were standardized by the Sandia Weapons Development Board December 11, 1951. The warhead was defined as the nuclear pit and capsule, high-explosive sphere, detonators, X-unit, firing switch, nuclear insertion mechanism, and all hardware and cabling pertaining to these items. The warhead installation included the warhead, arming and fuzing system, power supply, and installation hardware. The warhead installation thus might vary for different missiles, even though the same warhead was used.[25]

The XW-5 Warhead would contain a Mk 5 Bomb implosion system, a Mk 5 Firing Set with a fast-firing X-unit and switch for contact bursts, and a new linear nuclear insertion mechanism.[26] Mk 5 nuclear capsules would be

used. This would produce a warhead 44 inches in diameter and 75-1/2 inches in length with a weight of 2550 pounds, excluding power supply, arming and fuzing, and mounting hardware.[27]

The Sandia Weapons Development Board ruled that the warhead installation should not be design released until six successful tests of the warhead in the missile had been made. Missile availability dates were still largely indefinite, but it was felt that at least 9 months would be required between design release and early production.

The Mk 5 Mod 0 Warhead was design released August 1953, and production was achieved July 1954. The warhead incorporated a linear nuclear insertion mechanism, but otherwise was identical with the Mk 5 Bomb less outer case. (b)(1), (b)(3)

A Mk 5 Mod 1 Warhead was proposed for use with the RASCAL missile, incorporating dual-motor nuclear insertion mechanism, but was canceled during design, April 16, 1956.[28]

Sandia noted that the mid-1952 date could only be achieved by an expedited development program, and it was not definite that either XW-5 or XW-8 Warheads would be available by early 1953. Submarine storage and use were not expected to be a problem, although special finishes and packaging would have to be developed to protect against humidity.[29]

An X- / REGULUS Ad Hoc Working Group was appointed and held its first meeting September 10, 1951. Several types of arming and fuzing systems were discussed, and it was agreed, in view of program urgency, to use existing components insofar as possible.[30] Thus, the arming mechanism would be a combination of timer and baroswitch, with the fuze having two Albert radars.

(b)(1), (b)(3)

Nonradiating fuzes were desirable but, in the event that a radar fuze was used, its minimum jamming resistance should approximate that of an improved Abee or Albert. External setting of the burst height just prior to missile launching was desired, as was a universal fuze that could be used with all missiles.[31]

It was decided that a simple timer-baroswitch device should be used in the initial arming design, with an electromechanical system developed for later use. A command arming system was also to be provided, to be employed in conjunction with the timer when operationally desirable. The Navy would

gn fuz arh f c e

Investigation was undertaken of both forward extending pressure probes and trailing devices. It was hoped to develop a simple barometric fuze, but tests showed that the pressure pickups did not give reproducible results, and that the missile would have to travel faster than Mach 1.0 to prevent premature fuze operation.[32] A decision was made to use a baro-armed radar fuze, a modification of the fuze design of the Mk 5 Bomb.[33]

In early 1952 the Mk 5/REGULUS was given a higher priority than its Mk 8 counterpart, since there was a limitation in the number of missiles available for test flights.[34] Work was started on a contact fuze for several missiles, and successful completion of this task made it possible to provide the XW-5/REGULUS with two fuzing options; radar air burst with contact-fuze backup, and surface burst by impact crystals.

The Navy had requested that a pure barometric fuze be developed, and this was discussed in the June 27, 1952, meeting of the Ad Hoc Working Group. Sandia reported that this design would require an additional 10 months, and that it was not at all certain that such fuze would have the required accuracy. The Group, after considerable discussion, decided to approve the radar fuze for use in the REGULUS and to continue development of a barometric fuze.

The RAM Program (for REGULUS Assault Missile) was initiated by a letter from the Military Liaison Committee to the Division of Military Application August 18, 1952. This was a project to provide the capability for launching the REGULUS missile from a surface ship, guiding the missile to target, and arming and detonating the warhead by command from carrier-based fighter aircraft.[35]

The program was given a high priority in mid-February 1953, and a small number of Mk 5 Bombs were placed in standby storage April 1953, together with the hardware to convert these bombs to RAM installation, which had been renamed the REGULUS Interim Capability Program. These units were subsequently retired in mid-1954, as normal XW-5/REGULUS components became available.[36]

A new high-speed missile, the REGULUS II, was being developed. This would travel at twice the speed of the original REGULUS, or about Mach 2.0, and this increased velocity would more than double the ability of the missile to penetrate enemy defenses without being shot down. Test vehicles of the new design would be available by the fall of 1955, and a feasibility study was authorized by the Secretary of Defense December 1953.[38] The REGULUS II program was promoted to full-scale development stage in April 1955.[39]

Tests of the pressure-sensing system for the XW-5/RG-X1 showed that excessive lag was involved. This was traced to collapse of rubber tubing in the system, and was corrected by the use of metal tubing. This, however, required additional missile flights, and the design release date was postponed to January 1955.

On August 19, 1954, the Military Liaison Committee proposed that responsibility for REGULUS adaption kits be transferred to the Navy. A meeting was held October 28, 1954, at which it was decided that this transfer would be made July 1, 1955.[40]

(b)(3)

Inflight insertion and command arming were accomplished satisfactorily, although the flight came to an abrupt termination when the warhead was accidentally detonated just short of the target. However, missile and warhead performance were satisfactory throughout the 23-minute flight, which covered 173 miles.[41]

Evaluation flights from submarines were largely successful. Impact tests indicated that the contact crystals generated sufficient voltage to detonate the warhead, and that this detonation occurred prior to warhead deformation. Impacts produced by travel through rain or hail, however, would not cause premature detonation. Thus, the system was given general release.

It had been suggested that the design with the barometric fuze be identified as a Mod change upon entry into stockpile. Action on this suggestion, however, was tabled pending assumption of design control by the Navy. Subsequently, it was decided that the Mk 5 Warhead would be replaced by the Mk 27, and all Sandia activity was suspended on the Mk 5/REGULUS Warhead Installation March 1, 1956.[42]

CHAPTER III

MK 5/MATADOR WARHEAD

The MATADOR was a surface-to-surface, turbojet-powered, transonic missile with a range of about 600 nautical miles. The missile was constructed in the shape of a streamlined fighter plane with an over-all length of 39 feet, maximum diameter of slightly over 4 feet, and swept-back wings. It was launched from a zero-length launcher by a single, solid-propellant rocket, which accelerated the missile until the turbojet engine could attain enough thrust to sustain flight. This rocket booster was pneumatically ejected at time of burnout.

At launch, the missile climbed to an altitude of 40,000 feet, then followed a level trajectory to a "dump point" where it pushed over and dove into the target. Two guidance systems were proposed for use, Shanicle and Marc. Shanicle used four ground stations, which generated guidance beams. The missile received these signals and converted them into azimuth and range guidance. Marc used two trailers that tracked the missile and sent command signals. When the "dive point" was reached with either system, the missile followed a programmed terminal trajectory to the target. MATADOR was designed and built by the Glenn L. Martin Company for the Air Force.

The missile was initially considered for marriage with an XW-5 atomic warhead in early 1950.[43] The MATADOR project was accelerated in late 1950, due to the situation in Korea, and on December 18, 1950, the Joint Chiefs of Staff recommended to the Secretary of Defense that a number of missile projects be approved, among them the MATADOR.[44]

Much of 1951 was taken up with consideration of the solution of general problems relating to the development of atomic warheads for guided missiles, and it was not until October 3, 1951, that an XW-5/MATADOR Ad Hoc Working Group was named by the Guided Missiles Committee and held its first meeting. The Group proposed that both radiating and nonradiating fuzes be considered,

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Figure 4. RACHEL Missile

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CHAPTER IV

MK 5/RASCAL WARHEAD

The RASCAL was an air-to-surface, rocket-powered, supersonic missile with a 90-nautical-mile range. The missile was 32 feet long and 4 feet in diameter, with one set of four fins near the nose and another at the tail. The missile was developed by the Bell Aircraft Company for the Air Force. Its name was formed from the title RAdar SCAnning Link.[61]

After launch from the carrying bomber at an altitude between 30,000 and 40,000 feet, the RASCAL was to climb to an altitude of 60,000 feet, and cruise at Mach 2.5. The missile was given mid-course guidance by the launch aircraft. Terminal guidance during the dive to the target was provided by an inertial system and terminal guidance radar which searched the target area and relayed a video output to the launch aircraft. In this airplane, one operator tracked the target in range while another operator tracked it in azimuth. This information was fed into a computer which relayed guidance commands to the missile.

The program was initially proposed in a letter from the Military Liaison Committee March 16, 1950, which listed several missiles which were to be considered for marriage with nuclear warheads. The August 20, 1950, meeting of the Sandia Weapons Development Board noted that it should be fairly easy to develop a nuclear insertion device for the missile, and that the RASCAL had several features that made it particularly appropriate for use. The missile terminal guidance system contained information concerning height of the missile above target, and could be used as the warhead fuze. The missile would be launched only after the mother plane had penetrated enemy territory, so the warhead could be armed before launch.

replied that the Air Force still desired a RASCAL capability with the XW-5 Warhead, and that Mk 5 flight tests were now scheduled for the period January through September 1956, while missiles configured to carry the XW-27 would not be available until October 1956.[72]

However, further study and negotiation resulted in cancellation of the Mk 5/RASCAL program in March 1956. A quantity of components and hardware to convert Mk 5 Bombs to XW-5-X1/RASCAL warhead installations was retained for a temporary period for possible combat use.[73]

CHAPTER V

MISCELLANEOUS MISSILES

RIGEL

Field Command notified Sandia August 28, 1950, that the Navy was planning to incorporate a Mk 5 Warhead into the RIGEL guided missile.[74] Information regarding this missile was requested from its contractor, the Grumman Aircraft Engineering Corporation, during a missile conference held at Sandia Base September 27-28, 1950. The Navy requested that provisions be made for the RIGEL to carry either the Mk 5, Mk 7 or Mk 8 Warhead.

Field Command pointed out to Sandia, in a letter dated November 29, 1950, that design of the RIGEL contemplated boosted launch from a short-rail launcher. The booster rockets would accelerate the missile from rest to approximately Mach 1.7 in about 4 seconds, after which the boosters would be jettisoned and the ramjet engines would further accelerate the missile to a cruising speed of Mach 2. During the boost phase, the longitudinal acceleration would be as high as 17 g's, and it appeared possible that accelerations of 20 g's might be experienced for short periods of time.[75]

The Mk 5 Warhead could withstand accelerations of 8 to 10 g's, but reduction of RIGEL launch accelerations to this level would require a major program, involving several years of research into composition and burning rates of propellants. Since the prototype warhead for the RIGEL would not be needed until 1954, it was hoped that a rugged implosion-type warhead might be developed by that time, and a request was made that Sandia make preliminary study of a Mk 5 implosion design that could withstand longitudinal accelerations of 20 g's.

A set of detailed missile characteristics was furnished to Sandia April 25, 1951.[76] This described the RIGEL as a supersonic, submarine-to-surface,

bombardment missile with a maximum diameter of 45 inches, a length of over 45 feet, and able to carry a warhead weight of 3000 pounds.

After launch, the missile would climb to a cruising altitude of 50,000 feet and fly to an "area of influence" of guidance stations, where mid-course guidance would be provided. This system was a modified Loran type, using two submerged submarines as control stations. The missile would interrogate the submarines and fly along a hyperbolic path established by these replies. The replies were timed so that the missile path would pass through a target release point. At this point the missile would automatically push over into either a programmed ballistic or homing path to the target. The first tactical missile firing was planned for November 1952, initial firing from a submarine in November 1954, and Fleet evaluation in December 1955.

Little subsequent work was done, however, and, September 30, 1953, the Division of Military Application notified Santa Fe Operations Office that the RIGEL program had been canceled and that requirements for an atomic warhead installation for this missile had been withdrawn.[77]

HERMES

The Sandia Weapons Development Board was notified March 13, 1951, that the Army was developing proximity fuzes for use with the HERMES missile carrying a conventional warhead. It was noted that the military characteristics for these fuzes were similar to those of atomic weapons, except for the higher reliability required in atomic weapons. Inasmuch as this increase in reliability could be achieved by using multiple fuzing, it was suggested that the Board make formal assignment of this project to the Army.[78]

On May 21, 1951, the Division of Military Application sent a teletype to Sandia, stating that the HERMES missile had been delcted from the marriage program, and that the Sandia program should be adjusted accordingly.[79] The

Military Liaison Committee notified the Division of Military Application on June 4, 1951, that the missile had been formally removed from the list of approved weapons projects, but that it had been added to the list of guided-missile test vehicles.[80]

Meetings were held in late 1951, to discuss the possibilities of reinstating the Mk 5 Warhead into the HERMES, so that a missile warhead-compartment design could be produced that would be compatible with Sandia's handling equipment. By May 27, 1952, schedules were being firmed up. Static tests would start April 1953, and flight tests July 1953. The missile operational date would be late 1954, with full production by early 1956. Operational suitability tests of the Mk 5 Warhead in the HERMES missile were planned for mid-1954.[81] General Electric Company, contractor for the HERMES missile, proposed that Sandia enter the project January 1954, by which date the third missile would be available for use.

Sandia was assigned design responsibility for the nose cone, which would have to be pressurized during flight to prevent electrical breakdown of the components. Some difficulty was anticipated with sealing problems, since the ring on which the nose cone was mounted did not lend itself readily to such designs. Sandia suggested, in a letter to Field Command June 9, 1952, that the nose cone be redesigned by the missile contractor, since it was closely associated with the missile airframe design.[82]

Sandia notified the Sandia Field Office of the AEC, June 11, 1952, that conferences with the missile contractor had determined that systems tests could start no earlier than October 1953. Design release would be accomplished by March 1954.[83]

Sandia wrote to Field Command September 25, 1952, stating that nose cones would be furnished for test flights of all HERMES missiles. These would contain inert warheads and Sandia-designed fuzes. It appeared that either a barometrically armed radar fuze or a pure barometric fuze would be used, but it was stated that design responsibility for the fuze had not been formally assigned.

On October 16, 1952, Field Command stated that, due to budget cuts, the HERMES program would be delayed about 6 months.[84] Thus, no current action would be taken on the formation of an Ad Hoc Working Group.[85]

Fiscal funds were still lacking by August 25, 1953.[86] On September 18, 1953, the Military Liaison Committee notified the Division of Military Application that the Army had terminated the development of the HERMES missile as an operational weapon, and that the requirement for an atomic warhead installation for this missile was accordingly withdrawn.[87]

F-101

On April 9, 1953, the Division of Military Application notified Santa Fe Operations Office that the Joint Chiefs of Staff had established a military requirement for development of a streamlined case to enable a supersonic fighter-type aircraft to externally carry the Mk 5 Bomb. Initial application was to be made to F-101 aircraft, and it was considered desirable that the Air Force proceed with the development of the case and the associated non-nuclear components.[88]

A study was made by Wright Air Development Center, after which the Air Force directed McDonnell Aircraft Corporation to develop an externally carried case, named Store 96. This Store was a symmetrical shape 394 inches long and with a maximum diameter of 44 inches. It had three tail fins, with the lower fin retractable to provide ground clearance for loading the weapon and for takeoffs and landings. Gross weight of the shape, including the Mk 5 Warhead and 849 gallons of fuel, was 9240 pounds. The fuel would be expended by the aircraft en route to the target, and, at release, with all fuel expended, the Store would weigh 3776 pounds. The weapon could be released from the carrying aircraft by low-altitude bombing release, M-1 bombing computing system, or by dive bombing, with optical sighting. An ejector mechanism would assist to separate the bomb from the airplane at release.

Glossary of Mk 5 Warhead Terms

Air Force Special Weapons Center — That element of the Air Force Systems Command having to do with compatibility testing of nuclear devices with aircraft. Located at Kirtland Air Force Base, Albuquerque, New Mexico.

Armed Forces Special Weapons Project — An interdepartment agency formed to handle military functions related to atomic weapons.

Barometric Fuze — Fuze incorporating a baroswitch. A pressure device actuated by increasing air pressure as the warhead descends in its trajectory.

Capsule — The nuclear ~~capsule~~ of an atomic weapon which, when subjected to compression in the implosion process, becomes supercritical and produces a nuclear reaction.

Cartridge — An assembly, generally containing fuzing and firing system elements, which can be inserted and removed from an atomic weapon in the manner of a cartridge being inserted or removed from the chamber of a rifle.

Contact Fuze — A fuze that detonates the weapon by contact with the ground or the target.

Department of Defense — The Armed Forces, i.e., the Army, Navy and Air Force.

Detonators — ~~Devices containing bridge wires which, when subjected to an electrical load, burn rapidly and act as a match to apply a flame to various points on the outer surface of the high explosive sphere.~~

Division of Military Application — An AEC office that functions as liaison between the Military and weapon designers and producers.

Dump — The point in its trajectory at which a guided missile "dumps" or turns toward the target.

Fat Man Bomb — The implosion device used during World War II in the attack on Nagasaki. So-called due to its bulging contour.

Field Command — The local office of the Armed Forces Special Weapons Project, located on Sandia Base, Albuquerque, New Mexico.

Fuze — A combination of the arming and firing devices of a weapon.

g — Force equal to one unit gravity.

Implosion — The effect created when a sphere of high explosive is detonated on its exterior surface. The force of the exploding wave is directed largely toward the center of the sphere.

Jato — Named for Jet-Assisted Take-Off. A jet device initially designed to assist heavily loaded aircraft to take off from short runways. Used as a boosting device in missile launching.

Joint Chiefs of Staff — An Army-Navy-Air Force group to determine policy and to develop joint strategic objectives of the Armed Forces.

Kiloton — A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is equivalent to the detonation effect of 1000 tons of high explosive.

Los Alamos Scientific Laboratory — A nuclear design organization located at Los Alamos, New Mexico.

Mach — A measure of speed. Mach 1.0 is the speed of sound, or 738 miles per hour at sea level.

Mark 27 — A relatively small and light thermonuclear weapon, developed both as bomb and warhead.

Military Liaison Committee — A Department of Defense Committee established by the Atomic Energy Act to advise and consult with the AEC on all matters relating to military applications of atomic energy.

Nautical Mile — A naval measurement of length. One nautical mile is equivalent to 6076.1033 feet, or the length of 1 minute of arc (1/21,600) of a great circle of the earth.

(b)(3)

Radar — Named for Radio Detecting and Ranging. Radars emit a pulse of high-frequency energy and measure the time lapse from that transmission to receipt of a reflected electrical "echo" from an object. This time measurement determines the distance of the object from the transmitting antenna of the radar.

Sandia Weapons Development Board — A joint Sandia-Military board at Sandia Base to provide local guidance on weapons design.

Santa Fe Operations Office — The local office of the Atomic Energy Commission (AEC) concerned with the operations of Sandia Corporation.

Special Weapons Development Board — Change of name for the Sandia Weapons Development Board, effective May 14, 1952.

Subsonic — Any speed below that of Mach 1.0, which is the speed of sound, or 738 miles per hour at sea level.

Supersonic — Any speed exceeding that of Mach 1.0.

Telemetry — The transmission of signals from a moving object.

Thermonuclear — Two-stage reaction, with a fission device exploding and starting a fusion reaction in light elements.

X-Unit — ~~A high voltage transformer~~ A device used to provide high voltage to the weapon detonators.

XW-8 — A gun-type weapon, designed for target penetration.

Z Division — A division of the Los Alamos Scientific Laboratory, elements of which moved to Sandia Base and became the nucleus of Sandia Laboratory.

26. SRD Ltr, TX-N Steering Committee to Los Alamos Scientific Laboratory and Sandia Corporation, dtd 12/4/51, subject, XW-5 Warhead and Warhead Installation Development Program. SC Archives, microfilm reel MF-SF-SC-134.

27. SRD Report, TX-N Steering Committee to Distribution, dtd 12/4/51, subject, Tentative Characteristics of the XW-5 Warhead and XW-5/Missile Warhead Installations. SC Archives, microfilm reel MF-SF-SC-103.

28. CRD Ltr, Sandia Corporation to Distribution, dtd 5/16/56, subject, Cancellation of XW-5-X1 Warhead Development Program. SC Central Technical Files, XW 5-1, 5-2.

29. SRD Ltr, Sandia Corporation to Armed Forces Special Weapons Project, dtd 1/23/51, subject, Sandia Corporation Preliminary Comments on "Military Characteristics for Atomic Warheads for REGULUS (XSSM-N-8)." SC Archives, microfilm reel MF-SF-SC-138.

30. SRD Report, REGULUS/TX-5 Ad Hoc Working Group to Distribution, dtd 9/10/51, subject, Meeting Held August 16-17, 1951. SC Archives, microfilm reel MF-SF-SC-138.

31. SRD Minutes, REGULUS/TX-5 Ad Hoc Working Group to Distribution, dtd 9/18/51, subject, Minutes of 2nd Meeting. SC Central Technical Files, XW-5/REGULUS, 1-.

32. SRD Ltr, RS 3466/60759, Guided Missiles Committee to Special Weapons Development Board, 9/26/51, subject, Initial Recommendations on REGULUS/TX-5 Arming and Fuzing, Addendum D to the 55th Meeting of the Board. SC Archives, Transfer No. 48217.

33. SRD Ltr, Sandia Corporation to Armed Forces Special Weapons Project, dtd 9/26/51, subject, Nose Boom for REGULUS. SC Central Technical Files, XW-5/REGULUS, 1-.

34. SRD Ltr, Field Command to Sandia Corporation, dtd 1/18/52, subject, Relative Priorities for XW-5 and XW-8 Warheads for REGULUS Missiles. AEC Files, MRA-5, 1/52-11/52.

35. SRD Ltr, Military Liaison Committee to Division of Military Application, dtd 8/18/52, subject, Requirements in Connection with the REGULUS Assault Missile (Project RAM). SC Archives, microfilm reel, MF-SF-SC-138.

36. SRD Ltr, Santa Fe Operations Office to Sandia Corporation, dtd 6/2/54, subject, REGULUS Interim Capability. AEC Files, MRA-5, 5/54-6/54.

37. SRD Ltr, RS 1000/1415, Sandia Corporation to Field Command, dtd 10/6/53, subject, High Altitude Capabilities of the XW-5/REGULUS. AEC Files, MRA-5, REGULUS, Vol. IV.

38. SRD Ltr, Division of Military Application to Santa Fe Operations Office, dtd 12/10/53, subject, Supersonic REGULUS Warhead. AEC Files, MRA-5, 11/53-1/54.

51. SRD TWX, Santa Fe Operations Office to Sandia Field Office, AEC, dtd 4/9/53. AEC Files, MRA-5, MATADOR, Vol. II.

52. (b)(3)

53.

54. SRD Ltr, RS 1/565, Sandia Corporation to Division of Military Application, dtd 1/18/54, subject, Transmittal of Interim Design Status Report of the XW-5/B-61A MATADOR, SC2982(TR). AEC Files, MRA-5, 11/53-1/54.

55. SRD Ltr, Air Force Special Weapons Center to Sandia Corporation, dtd 2/24/54, subject, Design Improvements in the XW-5/B-61A Warhead Installation. AEC Files, MRA-5, 2/54-4/54.

56. SRD Ltr, Sandia Field Office, AEC, to Air Force Special Weapons Center, dtd 3/16/54, subject, Design Improvements in the XW-5/B-61A Warhead Installation. AEC Files, MRA-5, 2/54-4/54.

57. (b)(3)

58. SRD Minutes, RS 3466/80010, Special Weapons Development Board to Distribution, dtd 6/30/54, subject, Minutes of the 84th Meeting, Part I. SC Archives, Transfer No. 48217.

59. SRD Minutes, RS 3466/78375, Special Weapons Development Board to Distribution, dtd 7/13/55, subject, Minutes of the 94th Meeting, Part I. SC Archives, Transfer No. 48217.

60. SRD Ltr, Santa Fe Operations Office to Sandia Corporation, dtd 3/8/56, subject, Cancellation of XW-5-X1/TM-61C (MATADOR) Project. AEC Files, MRA-5, MATADOR, 7/55.

61. CRD Ltr, Sandia Corporation to Distribution, dtd 10/25/50, subject, Visit of Bell Aircraft Personnel Concerning the TX-5 Warhead for the RASCAL Missile. SC Archives, microfilm reel MF-SF-SC-135.

62. SRD Minutes, RASCAL/XW-5 Ad Hoc Working Group to Distribution, dtd 11/7/51, subject, Minutes of Meeting. SC Archives, microfilm reel MF-SF-SC-135.

63. SRD Ltr, RS 1000/958, Sandia Corporation to Sandia Field Office, AEC, dtd 5/24/52, subject, Estimated Complete Design Release Date for the XW-5/RASCAL Warhead Installation. AEC Files, MRA-5, 4/52-6/52.

77. SRD Ltr, Division of Military Application to Santa Fe Operations Office, dtd 9/30/53, subject, Cancellation of the U. S. Navy Guided Missile Program, XW-5/RIGEL. AEC Files, MRA-5, 9/53-10/53.

78. SRD Ltr, Department of the Army to Sandia Weapons Development Board, dtd 3/13/51, subject, Assignment of Project to Ordnance Corps. SC Archives, microfilm reel MF-SF-SC-134.

79. SRD TWX, Division of Military Application to Sandia Corporation, dtd 5/21/51. SC Archives, microfilm reel MF-SF-SC-103.

80. SRD Ltr, Military Liaison Committee to Division of Military Application, dtd 6/4/51, subject, Atomic Warheads for Guided Missiles. AEC Files, MRA-5, HERMES.

81. CRD Ltr, Internal Sandia Corporation, dtd 5/27/52, subject, Time Scales for XW-5/HERMES A3BE1 Warhead Installation. SC Archives, microfilm reel MF-SF-SC-133.

82. CRD Ltr, Sandia Corporation to Field Command, dtd 6/9/52, subject, HERMES A3BE1 Nose Cone. AEC Files, MRA-5, HERMES.

83. CRD Ltr, Sandia Corporation to Sandia Field Office, AEC, dtd 6/11/52, subject, Estimated Complete Design Release Date for the XW-5/HERMES A3BE1 Warhead Installation. SC Archives, microfilm reel MF-SF-SC-135.

84. SRD Ltr, Sandia Corporation to Armed Forces Special Weapons Project, dtd 9/25/52, subject, HERMES A3BE1 Nose Cone. SC Central Technical Files, XW-5/HERMES.

85. SRD Ltr, Sandia Field Office, AEC, to Santa Fe Operations Office, dtd 10/27/52, subject, Delay in HERMES A3BE1 Program. SC Central Technical Files, XW-5/HERMES.

86. SRD Ltr, Field Command to Sandia Corporation, dtd 8/25/53, subject, HERMES A3BE1 Program Rescheduling. AEC Files, MRA-5, HERMES.

87. SRD Ltr, Division of Military Application to Santa Fe Operations Office, dtd 9/30/53, subject, HERMES A3BE1 Program. AEC Files, MRA-5, 9/53-10/53.

88. CRD Ltr, Sandia Corporation to Division of Military Application, dtd 4/18/53, subject, External Carriage of the Mark 5 Type Warhead. SC Archives, Transfer No. 45199.

89. SRD Ltr, Sandia Corporation to Distribution, dtd 8/3/53, subject, Status of the TX-5/F-101 Program. SC Central Technical Files, XW-5/F-101, 2-, 1953-7.

90. CRD Charter, XW-5/F-101 Joint Project Group, dtd 8/7/53. SC Archives, microfilm reel MF-SF-SC-1447.

91. SRD Minutes, XW-5/F-101 Joint Project Group to Distribution, dtd 7/20/54, subject, Minutes of 3rd Meeting. SC Central Technical Files, XW-5/F-101, 1-, 1953-6.

92. SRD Ltr, Sandia Corporation to Division of Military Application, dtd 5/24/55, subject, Application of Class C and D Thermonuclear Warheads in the F-101 Special Store Shape 96. SC Central Technical Files, XW-5/F-101, 1-, 1953-6.

93. CRD Ltr, Air Force Special Weapons Center to Sandia Corporation, dtd 6/10/55, subject, Application of Class C and D Thermonuclear Warheads in the F-101 Special Store Shape 96. SC Central Technical Files, XW-5/F-101, 1-, 1953-6.

94. SRD Ltr, Sandia Corporation to Distribution, dtd 3/5/56, subject, Cancellation of XW-5/XW-27/F-101 Programs. SC Central Technical Files, XW-5/F-101, 2-, 1953-7.

95. SRD Report, Sandia Corporation to Distribution, dtd 4/5/56, subject, XW-5/F-101 Informal Status Report. SC Central Technical Files, XW-5/F-101, 2-, 1953-7.